

**CLAIMS:**

1. A method for automatically controlling the gain of an optical amplifier, comprising:
  - generating a first control signal based on a feed-forward error signal and a second control signal based on the feedback error signal;
  - adjusting the pump source in accordance with the control signals.
2. The method of claim 1 wherein the feed-forward error signal is proportional to a change in power of an optical signal received at an input to the optical amplifier.
3. The method of claim 1 wherein the feedback error signal is proportional to a difference between a desired gain and a measured gain, wherein the measured gain is determined from the power of an optical signal received at an input of the optical amplifier and the power of an optical signal received at an output of the optical amplifier.
4. The method of claim 1 wherein the feedback error signal is proportional to the difference between a desired ASE power and the power of ASE received at an output of the optical amplifier.
5. The method of claim 1 wherein the adjusting step is performed in accordance with a PID scheme.
6. The method of claim 2 wherein the control signal is based on the feed-forward error signal only when said change in the power of the optical signal received at the input to the optical amplifier exceeds a predetermined threshold.
7. The method of claim 1 wherein said optical amplifier is a rare-earth doped fiber amplifier.

8. The method of claim 8 wherein said rare-earth doped fiber amplifier is doped with erbium.
9. An optical amplifier with automatic gain control, comprising:
  - a rare-earth doped fiber for imparting gain to an optical signal propagating therethrough;
  - a pump source for supplying pump power to the rare-earth doped fiber;
  - a first optical power monitoring device for receiving a portion of output power generated by the rare-earth doped fiber and converting said portion of the output power to a first control signal;
  - a second optical power monitoring device for receiving a portion of the input optical signal and converting said portion of the input optical signal to a second control signal;
  - a controller receiving the first and second control signals and generating a bias current for driving the pump source, said bias current having a value based on at least first and second components, said first component being determined by the second control signal and not the first control signal and the second component being determined by at least the first control signal.
10. The optical amplifier of claim 9 wherein said portion of the output power generated by the rare-earth doped fiber is a portion of an amplified optical signal.
11. The optical amplifier of claim 9 wherein said portion of the output power generated by the rare-earth doped fiber is a portion of ASE.
12. The optical amplifier of claim 9 wherein said controller is a PID controller.
13. The optical amplifier of claim 9 wherein the bias current is based on the first component only when a change in power of the optical signal received at the input to the rare-earth doped fiber exceeds a predetermined threshold.

14. The optical amplifier of claim 9 further comprising an optical delay line located between a portion of the second monitoring device and the rare-earth doped fiber.

15. The optical amplifier of claim 14 wherein said optical delay imparts a delay to an optical signal traveling therethrough that is approximately equal to an automatic gain control loop latency.

16. The optical amplifier of claim 15 wherein said automatic gain control loop latency is determined by a sum of a response time of the controller, a response time of the pump source, and optical transit times between the second coupler and the controller and between the pump source and the rare-earth doped fiber.

17. The optical amplifier of claim 14 wherein said optical delay imparts a delay to an optical signal traveling therethrough that is greater than the sum of a response time of the controller, a response time of the pump source, and optical transit times between the second coupler and the controller and between the pump source and the rare-earth doped fiber.

18. The optical amplifier of claim 9 wherein said first optical power monitoring device includes a first coupler located at the output of the doped fiber and a first photodetector for converting said portion of the output power to the first control signal.

19. The optical amplifier of claim 9 wherein said second optical power monitoring device includes a second coupler located at the input of the doped fiber and a second photodetector for converting said portion of the input power to the second control signal.

20. The optical amplifier of claim 19 further comprising an optical delay line located between the second coupler and the rare-earth doped fiber.
21. A WDM optical communication system, comprising:
  - a plurality of network nodes, each of said nodes including an optical switch;
  - at least one optical communication link interconnecting said nodes;
  - at least one optical amplifier located along the communication link, said optical amplifier including:
    - a rare-earth doped fiber for imparting gain to an optical signal propagating therethrough;
    - a pump source for supplying pump power to the rare-earth doped fiber;
    - a first optical power monitoring device for receiving a portion of output power generated by the rare-earth doped fiber and converting said portion of the output power to a first control signal;
    - a second optical power monitoring device for receiving a portion of the input optical signal and converting said portion of the input optical signal to a second control signal;
    - a controller receiving the first and second control signals and generating a bias current for driving the pump source, said bias current having a value based on at least first and second components, said first component being determined by the second control signal and not the first control signal and the second component being determined by at least the first control signal.
22. The WDM optical communication system of claim 21 wherein said portion of the output power generated by the rare-earth doped fiber is a portion of an amplified optical signal.
23. The WDM optical communication system of claim 21 wherein said portion of the output power generated by the rare-earth doped fiber is a portion of ASE.

24. The WDM optical communication system of claim 22 wherein said controller is a PID controller.
25. The WDM optical communication system of claim 23 wherein the bias current is based on the first component only when a change in power of the optical signal received at the input to the rare-earth doped fiber exceeds a predetermined threshold.
26. The WDM optical communication system of claim 21 further comprising an optical delay line located between a portion of the second optical power monitoring device and the rare-earth doped fiber.
27. The WDM optical communication system of claim 26 wherein said optical delay imparts a delay to an optical signal traveling therethrough that is approximately equal to an automatic gain control loop latency.
28. The WDM optical communication system of claim 27 wherein said automatic gain control loop latency is determined by a sum of a response time of the controller, a response time of the pump source, and optical transit times between the second coupler and the controller and between the pump source and the rare-earth doped fiber.
29. The WDM optical communication system of claim 26 wherein said optical delay imparts a delay to an optical signal traveling therethrough that is greater than the sum of a response time of the controller, a response time of the pump source, and optical transit times between the second coupler and the controller and between the pump source and the rare-earth doped fiber.
30. The WDM optical communication system of claim 21 wherein said first optical power monitoring device includes a first coupler located at the output of the

doped fiber and a first photodetector for converting said portion of the output power to the first control signal.

31. The WDM optical communication system of claim 21 wherein said second optical power monitoring device includes a second coupler located at the input of the doped fiber and a second photodetector for converting said portion of the input power to the second control signal.

32. The WDM optical communication system of claim 31 further comprising an optical delay line located between the second coupler and the rare-earth doped fiber.

33. The method of claim 1 wherein, at select times, the adjustment of the pump source is based simultaneously on the first and second control signals.

34. The method of claim 1 wherein, at select times, the adjustment of the pump source is based only on the first control signal.

35. The method of claim 1 wherein, at select times, the adjustment of the pump source is based only on the second control signal.